# Pierre Auger Observatory
# Surface Detector micro-TPCB Specification

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## Purpose of the microTPCB

The microTPCB serves as a wiring nexus for the solar power system, provides analog signal conditioning for the quantities which need to be monitored for understanding of the operation of the solar power system, and provides fusing to prevent fire in the event of a catastrophic short circuit involving the batteries.

The design should be matched to the unified board design and to the selected solar power controller, the Morningstar SS1024V.

## Quantities to be measured

The table below summarizes the quantities which we need to measure. All measurements should be made as accurately as feasible at low cost using standard 1% components, with the minimum resolution and range as specified below. The measurements should be as precise and accurate as feasible at low cost over the operating temperature range expected in the hatch cover area (about -10C to 50 C). When a preliminary design is complete, we can discuss the use of a limited number of the more costly 0.1% components to improve the precision and accuracy of key measurements, particularly the battery voltages.

| Quantity | Range | Minimum Resolution |
|---|---|---|
| Battery + Voltage | 0-36V | ±0.12V |
| Battery Center Voltage | 0-18V | ±0.12V |
| Load Current | 0-1A | ±0.012A |
| Solar Panel Voltage | 0-50V | ±0.12V |
| Solar Panel Current | 0-5A | ±0.125A |
| Battery 1 Temperature | * | ±2 C |
| Battery 2 Temperature | * | ±2 C |

*Voltage Measurements:* The voltages required are the positive terminals of the batteries and of the solar panel positive terminal referenced to the local ground at the microTPCB. All voltages should be filtered with a time constant of several hundred milliseconds or greater to eliminate the effect of the PWM of the charging waveform on the solar panel.

*Current Measurements:* Required voltages are the current sourced from the battery area to the station electronics and microTPCB, and the current delivered by the solar panel. To maintain system grounding consistent with our grounding plan, these will need to be made using shunts on the high-side of the circuit.

We recommend the LT1787 and LT1787HV current sense amplifiers for the two current measurements. The HV version is needed for the solar panel voltages; it supports a maximum high-side voltage of 60V while the standard version is rated for 36V.

The filtering pins of these amplifiers should be used to reduce the bandwidth of the current sense to a few hundred Hz, using 0.1uF to 1uF ceramic capacitors. The final filtering may be performed using a buffer amplifier on the output designed to give a time constant of a few hundred milliseconds or more.

*Temperature Sensors:* These will be AD592 current source temperature sensors. They are supplied with +12V from the UB and return a current proportional to the absolute temperature. The appropriate load resistor (10K, 0.1%) is available on the unified board and so the microTPCB need only route the signals from the battery area to the unified board.

**Connector List**

There should be six connectors on the micro-TPCB. We suggest connectors available in right-angle PCB mount packages.

1) A connector for the solar panel, with two conductors (SP+, SP-). We recommend a Molex Mini-Fit Sr. two-circuit connector.

2) A connector for high current connections to the battery area. Four conductors (Load+, Load-,PV+,PV-). We recommend a Molex Mini-Fit Sr. four circuit connector.

3) A connector for the power feed to the UB. Two conductors (Pwr+, Pwr-). We recommend a Molex Mini-Fit Sr. two-circuit connector.

4) A connector for low current sense lines to the battery area. This consist of four twisted pairs (+12V, BattTemp1;+12V,BattTemp2; Batt+, BattRef; BattCenter, BattRef)

5) A connector giving the conditioned signals to the UB. The connector should be a DB15HD (male) with the pinout matching the UB pinout.

6) A connector redistributing the tank sensor signals from connector 5).

All conductors for 1)-3) should be #12AWG or larger. Others should be selected small gauges to match the requirements of the connectors used.

**Form Factor**

To use the same case as the WLAN transceiver, the design should be divided into two two layer PCBs with a board interconnect. One board will include all high current connectors (1-3) and the other the low current connectors (4-6). Sensing circuitry will be placed on the appropriate board to minimize connections between the two PCBs.

**Fusing**

Fuses will be used to protect the system from catastrophic short-circuits. The load may be fused at 1A, slow-blow. The solar panel may be fused at 5A, slow blow. Soldered fuses with the form factor of 1/2W through-hole resistors will be used. The selected fuses correspond to derating by roughly a factor of two. These fuses can be soldered components with the form factor of through-hole resistors, since the repair philosophy for the microTPCB is to swap the unit in the field in the event of a failure.

**Construction**

The microTPCB should be designed using through-hole components where possible, and selecting components commonly available in Argentina where possible. Key components could in principle be purchased in the US and shipped to Argentina under waiver if this results in significant savings to the project..

**Unified Board Pinout**

The connection to the unified board is made using a DB15HD connector with the pinout shown below. The impedance of all inputs is 10 Kohm. All inputs are 0-5V, have 100 nF shunt capacitance prior to the multiplexer, and an additional 10 nF placed in the circuit after the multiplexer. Temperature sensors have 0.1% load resistors; all other load resistors are 1%. The ADC has a resolution of 12 bits.

| Pin | Signal | Comment |
|---|---|---|
| 1 | +12V | 10 ohm output impedance; reserved for power feed to future sensors (*e.g.* water level) |
| 2 | +12V | 1 Kohm output impedance; for a temperature sensor. |
| 3 | BATTCENT | Battery center tap voltage, scaled to 0-5V |
| 4 | +12V | 1 Kohm output impedance; for a temperature sensor. |
| 5 | +12V | 1 Kohm output impedance; for a temperature sensor. |
| 6 | GND | Unified board systen |
| 7 | EXTTEMP | Battery temperature current source return, AD 592 (1 microamp/K). For an optional external temperature sensor, placed in the shade of the solar panel. |
| 8 | LOADCURR | |
| 9 | BATEMP1 | Battery temperature current source return, AD 592 (1 microamp/K) |
| 10 | BATEMP2 | Battery temperature current source return, AD 592 (1 microamp/K) |
| 11 | WATLEV | Reserved for water level sensor or other future sensor. 0-5V |
| 12 | BATTOT | Battery positive voltage, scaled to 0-5V |
| 13 | SPVOLT | Solar panel voltage, scaled to 0-5V |
| 14 | SPCURR | Solar panel current, scaled to 0-5V |
| 15 | DACOUT4 | Reserved for future use. |